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Electromagnetic Compatibility (EMC) - Part 1-2: General - Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena

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Electromagnetic compatibility (EMC) –

Part 1-2:
General – Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 1-2: General – Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

IEC 61000-1-2, which is a technical specification, has been prepared by technical committee 77: Electromagnetic compatibility. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
77/231/CDV	77/235/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A, B, C, D, and E are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be:

- transformed into an International Standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

Immunity limits (insofar as they do not fall under the responsibility of the product committees)

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

Part 6: Generic standards

Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as International Standards or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and completed by a second number identifying the subdivision (example: 61000-3-11).

The function of electrical or electronic equipment should not be affected by external influences in a way which could lead to an unacceptable risk of harm to the users, other persons, animals or property. A comprehensive safety analysis should consider various factors of climatic, mechanical, electrical nature and even reasonably foreseeable misuse. Electromagnetic disturbances are present in most environments and should therefore be considered during such an analysis.

The purpose of this document is to provide guidance relating to the achievement of functional safety of electrical or electronic equipment exposed to electromagnetic disturbances. With respect to consistency within IEC, the document makes use, as far as appropriate, of existing relevant basic IEC standards. It considers in particular the work of SC 65A relating to safety concepts (e.g. IEC 61508), of TC 56 relating to assessment methods (e.g. IEC 60300-3-1 and IEC 61025) and of course of TC 77, its subcommittees and CISPR relating to the electromagnetic environments. For details on these subjects reference should be made to the standards of these committees.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 1-2: General – Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena

1 Scope and object

This technical specification specifies a methodology for the achievement of functional safety with regard to electromagnetic (EM) phenomena of electrical and electronic equipment: apparatuses, systems and installations, as installed and used under operational conditions.

It specifies procedures for

– determining requirements;
– requirements;
– design aspects including installation of the equipment;
– analytical assessment methods;
– testing recommendations;
– documentation.

It is not concerned with direct hazards from electromagnetic fields on living beings nor is it concerned with safety related to breakdown of insulation or other mechanisms by which persons can be exposed to electrical hazards.

This technical specification applies to the influence of the electromagnetic environment including adjacent devices on apparatuses and small or large systems, however not to the influence of internal sources in the apparatuses, which have to be considered in relation with their design.

It is intended for product committees, designers, manufacturers and installers of equipment and systems.

This document is focused on the safety analysis and testing methods related to electromagnetic influences. With regard to quantitative assessment methods, i.e. probability of failures, the methods described in the IEC 61508 series can be applied.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this technical specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

IEC 60300-3-1:1991, *Dependability management – Part 3: Application guide – Section 1: Analysis techniques for dependability: Guide on methodology*

IEC 61000-1-1:1992, *Electromagnetic compatibility (EMC) – Part 1: General – Section 1: Application and interpretation of fundamental definitions and terms*

IEC 61000-2 (all parts), *Electromagnetic compatibility (EMC) – Part 2: Environment*

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques*

IEC 61000-4-1:2000, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series*

NOTE IEC 61000-4-1 provides general information on all the basic immunity tests.

IEC 61025:1990, *Fault tree analysis (FTA)*

IEC 61508-1:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2:2000, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

IEC 61508-5:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 5: Examples of methods for the determination of safety integrity levels*

IEC 61508-6:2000, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3*

IEC 61508-7:2000, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

3 Definitions and abbreviations

For the purposes of this technical specification, the definitions contained in IEC 60050(161) and IEC 60050(191), as well as the following apply.

3.1
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[IEV 161-01-05]

3.2
electromagnetic interference (EMI)
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

[IEV 161-01-06]

NOTE Disturbance and interference are respectively cause and effect.

3.3
electromagnetic compatibility (EMC)
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 161-01-07]

3.4
electromagnetic compatibility level
specified electromagnetic disturbance level used as a reference level for co-ordination in the setting of emission and immunity limits

[IEV 161-03-10, modified]

NOTE 1 By convention, the compatibility level is chosen so that there is only a small probability that it will be exceeded by the actual disturbance level. However electromagnetic compatibility is achieved only if the emission and immunity levels are controlled such that, at each location, the disturbance level resulting from the cumulative emissions is lower than the immunity level for each device, equipment and system situated at the same location.

NOTE 2 The compatibility level may be phenomena-, time- or location-dependent.

3.5
electromagnetic environment
the totality of electromagnetic phenomena existing at a given location

[IEV 161-01-01]

3.6
dependability
collective term used to describe the availability performance and its influencing factors: reliability performance, maintainability performance and maintenance support performance

NOTE Dependability is used only for general descriptions in non-quantitative terms.

[IEV 191-02-03]

3.7
degradation (of performance)
undesired departure in the operational performance of any device, equipment or system from its intended performance

NOTE The term "degradation" can apply to temporary or permanent failure.

[IEV 161-01-19]

3.8
failure
termination of the ability of an item to perform a required function

[IEV 191-04-01]

3.9
fault
state of an item characterised by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

[IEV 191-05-01]

NOTE

a) "Failure" is an event, as distinguished from "fault", which is a state.

b) After failure the item has a fault.

c) This concept as defined does not apply to items consisting of software only.

d) A fault is often the result of a failure of the item itself, but may exist without prior failure.

3.10
harm
physical injury and/or damage to health or property

[ISO/IEC Guide 51:1999, definition 3.3]

3.11
hazard
potential source of harm

[ISO/IEC Guide 51:1999, definition 3.5]

3.12
risk
probable rate of occurrence of a hazard causing harm and the degree of severity of the harm

[ISO/IEC Guide 51:1999, definition 3.2]

3.13
reasonably foreseeable misuse
use of a product, process or service under conditions or for purposes not intended by the supplier, but which may happen, induced by the design of the product in combination with, or as result of, common human behaviour

[ISO/IEC Guide 51:1999, definition 3.14]

3.14
functional safety
freedom from an unacceptable risk of harm due to the malfunctioning of the equipment or a system including that resulting from reasonably foreseeable misuse

3.15
safety integrity
probability that electric or electronic equipment will perform satisfactorily with regards to the safety functions under all the stated conditions within a stated period of time

[IEC 61508-4,1998, definition 3.5.2, modified]

3.16
validation
confirmation by examination and provision of objective evidence that the particular requirements for a specified intended use are fulfilled

[ISO 9000:2000, definition 3.8.5]

3.17
fault tree analysis (FTA)
deductive (top-down) method for analysing system dependability

3.18
basic event
in fault tree analysis, a single input event – at the bottom of the fault tree – which may influence the operation of the considered equipment or system

NOTE 1 A basic event may be an independent event (see note 2) or the output of another fault tree.

NOTE 2 In the context of this technical specification a basic event is an electromagnetic disturbance.

3.19
top event
in fault tree analysis, the output event – at the top of the fault tree – resulting from the effect of all external, internal and other conditions

NOTE In the context of this technical specification the top event represents a hazardous situation which should be avoided.

3.20
apparatus (in the context of EMC documents)
a single piece of equipment with (a) direct function(s) intended for final use

3.21
system (in the context of EMC documents)
a combination of apparatuses and/or active components constituting a single functional unit and intended to be installed and operated to perform (a) specific task(s)

NOTE "Safety related systems" are specifically "designed" equipment that both:

– implement the required safety functions necessary to achieve or maintain a safe state for a controlled equipment ;

– are intended to achieve on their own or with other safety-related equipment or external risk reduction facilities, the necessary safety integrity for the required safety requirements.

[IEC 61508-4, definition 3.4.1, modified]

3.22
installation (in the context of EMC documents)
a combination of apparatuses, components and systems assembled and/or erected (individually) in a given area. For physical reasons (e.g. long distances between individual items) it is in many cases not possible to test an installation as a unit

4 General considerations

Electromagnetic disturbances can influence the functional safety of the equipment or system.

The aim with regard to EMC and functional safety is to assess the possible effects of electromagnetic disturbances on the total risk and to design, manufacture and install the equipment or system so that there will be no more than a tolerable risk contribution from these phenomena.

It shall be noted that the equipment or system may comprise, in addition to the elements (parts and components) necessary for the achievement of its functions, special safety-related elements or subsystems and functions. Particular attention has to be given to the functional safety of these parts [see parts 1 to 7 of IEC 61508].

The correct and – in the context of this document – safe operation of an electrical or electronic equipment or system depends on two factors:

– the EM environment and the emission levels of the various sources;
– the immunity of the influenced devices.

As for the EM emissions, the allowed maximum emission levels are specified by the relevant committees[1], and it is not allowed under normal conditions to exceed these levels. However, this can occur occasionally under abnormal conditions.

As for immunity, the effects of a variation in performance according to statistical distribution for mass products and also the possible effects of ageing should be considered.

These two aspects of EMC shall be taken into account when specifying safety requirements and appropriate safety margins may be necessary.

Whether a test on the influence of an electromagnetic phenomenon on the behaviour of an equipment should be included in an EMC standard (or clause) or in a safety standard (or clause) is dependent on the approval criterion:

– If it is required that during or after the test the equipment continue to operate as intended, the test should be included in an EMC immunity standard (or clause) of a product (product family).
– If it is required that during or after the test no unsafe situation occurs (performance may be degraded incidentally or permanently, but not resulting in an unsafe situation), the test should be included in a safety standard (or clause). It is obvious that for products with safety functions the immunity levels may be chosen to be higher than in the generic standards for that environment.

5 The achievement of functional safety

5.1 Safety life cycle

The achievement of functional safety requires consideration to be given to EMC throughout the life cycle of the equipment or system from the concept stage to decommissioning. This is represented for individual equipment in figure 1, for systems in figure 2.

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[1] Mainly TC 77 and CISPR.